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**The Impact of an Intelligent Computer-Based Tutor on
Classroom Social Processes: An Ethnographic Study**

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This document is submitted as the final report of project NR 702-013. It consists of two parts. First, I present a summary of the research activities conducted and the findings emerging from the project. Then, I list the publications and presentations stemming from this work. Since a complete description of the research activities, as well as discussion of virtually all of the project's important findings, is found in the forthcoming book mentioned on the publications list, I have decided to organize this report by summarizing the material covered in that book.

The book, the working title of which is Computers in the Classroom, is built around two basic themes. First, it demonstrates that using computers in schools has profound effects on aspects of classroom life which neither those who design the software nor those who decide to adopt it anticipate. Second, it argues that although the use of computers can alter important aspects of classroom life, longstanding patterns of social organization in both the school and the larger society markedly influence computer use in ways which do not always work to the students' advantage.

After an introductory section which lays out the general issues to be examined in the book, the opening chapter of Computers in the Classroom describes both the site at which the research was conducted and the methods employed. Data-gathering took place during a two-year period in a large urban high school which serves approximately 1,300 students from extremely varied socioeconomic backgrounds. Roughly 55% of the students were African-American, 40% were Caucasian, and 5% were from other, primarily Asian, backgrounds.

There were several factors which made Whitmore High School (a pseudonym) attractive as the site for this research. First, and most importantly, this school was the site of a field test for the GPTutor, bution/

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an artificially-intelligent computer-based tutor designed to help teach students geometry proofs. In addition Whitmore had computers available for use for much more common applications, such as teaching word processing in business classes and programming in computer science classes. This allowed the exploration of one unusual but potentially very important usage of microcomputers -- their use as intelligent tutors -- as well as a comparison between the effects of this rather advanced application and other much more common ones. Second, the school's relatively diverse student body made it possible to observe the reactions to computer use of a much broader range of students than would have been possible in a more homogeneous school. Third, the achievement level of the school's students, as indicated on standardized tests, was close to average for the nation as a whole. This fact by no means warrants blithe generalization from the school studied to some hypothetical "average" school in the U.S. However, it does make it likely that the observations stemming from this study will have broader applicability than if it had been conducted in a school with either unusually strong or weak students.

The two major methods of data-gathering utilized in this study were intensive qualitative classroom observations and repeated semi-structured interviews. Observations were conducted using the "full field note" method of data collection (Olson, 1976) which involves taking extensive handwritten notes during the events being observed. Shortly thereafter these notes were audiotaped and transcribed.

A team of three researchers observed extensively in eight different classrooms before, during, and after the period in which these classes used the GPTutor. In addition, "control" classrooms taught by the same teachers without the use of the computer-based tutors were observed. Observations were also conducted in "comparison" classrooms taught by two

other geometry teachers. Protracted observations were also carried out in computer science classes, business classes, and a computer lab reserved for the use of gifted students. Over a two-year period, more than 400 hours were devoted to these firsthand observations.

Observers, no matter how omnipresent and insightful, are at a great disadvantage if they do not test their emerging ideas through direct inquiry with those whom they are observing. Because interviews can be so useful in providing participants' perspectives on events, both formal and informal interviews were conducted extensively. In constructing and conducting these interviews, strong efforts were made to procure valid and unbiased data, just as great care was taken during the observations to present as full and unbiased a picture of classroom social processes as possible. For example, questions were posed in a balanced manner so that leading questions were avoided, students were assured that their teachers would not have access to their interview transcripts, and the like.

Both students and teachers from all of the observed classrooms (Geometry, Computer Science 1 and 2, Office Automation, Business Computer Applications, the gifted computer laboratory) were interviewed as were a sample of "control" and "comparison" geometry students. In cases in which we decided not to interview all students in a given setting, stratified random sampling techniques were used to select respondents. In addition to interviewing the computer-using teachers mentioned above, we also interviewed a sample of teachers who had computers available for use but who had decided not to use them. Formal interviews were routinely audiotaped and transcribed. Informal interviews were also conducted frequently. In the geometry classes students were interviewed both before and after using the computer-based tutors. In most other settings

students were interviewed once in the second semester of the school year. A total of almost 275 formal interviews with students and teachers were conducted during the course of this research.

Data analysis followed the procedures outlined in classic works on qualitative research such as Miles and Huberman (1984), Bogdan and Biklen (1982), and Strauss (1987). This involves carefully reviewing field notes as they are collected, creating coding categories of various types, developing and refining coding systems, writing working memos, and then searching for ways to refute or refine the ideas emerging from the preceding activities. Formal interviews were typically analyzed using content analysis procedures. Informal interviews were coded in a fashion similar to the field notes.

Chapter 2 of Computers in the Classroom shifts the focus of attention from methodological issues to the presentation of substantive results. Specifically, it describes the results of the study of the artificially-intelligent geometry proofs tutor. Use of the GPTutor had a clear impact on both students' and teachers' behavior. The teachers changed their allocation of time, spending more time than previously with the less skilled students. In addition, they acted in a much more collegial fashion toward students than they had previously and increased their weighing of effort in assigning grades. Students using the GPTutor showed a marked increase in task-related effort and involvement. This change in their behavior appeared to be due to several interwoven factors. First, use of the tutor led to a substantial increase in overt but good-natured competition between students. In general, this competition appeared to be motivating. Second, students seemed to enjoy working on proofs more, which was also motivating. This increased enjoyment appeared to be due to factors as disparate as a decreased sense

of embarrassment about mistakes and an increased ability to express frustration and anger freely in a way students could not when dealing with a teacher unless they were willing to incur serious sanctions. Overall, students' reactions to the tutor, while very positive, appeared to be influenced by many factors which neither the tutor's designers nor their teachers anticipated. The use of the GPTutor changed classroom social processes and these social processes in turn influenced students' reactions to the tutors.

Chapter 3 of the book reports the results of the work conducted in the computer science classes. Observations and interviews led to the conclusion that students reacted very differently to the time they spent in the computer lab working on writing programs and the time they spent in the classroom where they learned about computers and programming through teacher-led lectures. Specifically, they enjoyed the lab much more and were more highly motivated to work in that setting. Analysis of the social processes in these two contrasting settings suggests that the students' increased motivation in the lab had some of the same causes as the increased motivation in the classrooms using the GPTutor. Important among these factors was a changed relationship with the teacher. Specifically, student-teacher relations were much more collegial in the lab than in the classroom. Students had increased control over these interactions and came to see the teacher as an individual who worked at solving problems, as they did, rather than as a repository of an endless supply of facts which must be learned. Also contributing importantly to the students' positive attitudes towards working in the computer lab was their changed relations with peers, who became an important source of help in the lab, unlike the situation in the computer science classroom in which interaction between students was discouraged because it

conflicted with the teachers' desire to convey information through a lecture format. Finally, students found work in the lab much more interesting than work in the classroom because they perceived a much more direct connection between it and their own personal everyday interests.

The next three chapters of Computers in the Classroom relate to the book's second focus, an exploration of the ways in which computer use is shaped by the social context in which it occurs. The first chapter in this section explores a widespread phenomenon which was very evident at the school studied -- the failure of many teachers to make any significant instructional use of computers that were available to them. It discusses a wide range of attitudinal and organizational factors which contributed to this situation. Important attitudinal barriers included the belief that computer usage would add little value to current practice and the threat to the teacher's sense of competence and authority posed by the fact that the teachers generally knew relatively little about computer use. This threat was greatly enhanced in situations in which teachers believed that some of their students knew more about computers than they did.

Several clear problems with the training the teachers received reduced the chances that it was sufficient to overcome their initial lack of confidence about using computers in their classes. Major problems with the training included (a) failure to match the kind of training provided with the teachers level of initial expertise; (b) failure to provide training relevant to the teacher's instructional concerns, including serious concerns about how computer usage would influence the organization of time and activity in their classrooms; (c) lack of concentrated experiential training; and (d) failure to coordinate the timing of training with the arrival of software and hardware at the

school. Infrastructure problems also abounded and inhibited the ready use of computers for instructional purposes. The most serious of these was the failure to provide adequate support to computer-using teachers to insure timely assistance from knowledgeable individuals. Since no individual was designated to serve this function within the school, knowledgeable teachers were overloaded to the point where they sometimes discouraged others from using computers more because increased usage created a greater burden on those few with sufficient knowledge to assist others.

Having examined the factors which shape the teachers' willingness to use computers for instructional purposes, the book next turns to looking at a factor which appears to have a crucial impact on students' reactions to computer use -- gender. Male students were both much more likely to enroll in the advanced computer science courses and to go to the computer lab available to gifted students during their lunch hour than were their female peers. In contrast, female students were more likely to enroll in business classes which taught word processing. Two chapters explore some of the reasons for and the consequences of gender-linked patterns such as these.

The first of these two chapters explores the question of why the computer lab, which was open to gifted students for their use at lunchtime, evolved informally to function virtually as a club for gifted white boys, in spite of the fact that almost exactly half of the students in the gifted program were girls. To lay the groundwork for exploring this question, the chapter first examines at some length gender roles at the school studied and concludes that students' attitudes and behavior were quite consistent with traditional conceptions of gender roles. Thus, for example, boys tended to emphasize strength and athletic prowess and

to highlight their own strong points in an overtly competitive way. In contrast, girls paid a considerable amount of very open attention to grooming themselves and devoted much of their socializing to chatting with their friends about their boyfriends, their family, or other girls.

The chapter then goes on to argue that the computer lab served as a sort of refuge for very bright white boys, many of whom were freshman or sophomores, from the hurly burly of the cafeteria, a milieu in which they were not very comfortable because they typically lacked the attributes conducive to male social success there. The lab, with its collection of computer games such as Where in the World is Carmen Santiago?, provided a milieu in which these boys could fantasize about their prowess and indulge their desire for challenge and competition without the potentially threatening presence of others who were nearer the traditional male ideal in many respects. In contrast, the gifted girls' emphasis on talking with friends meant that they could engage quite comfortably in their most preferred social activities without coming to the lab. In addition, the lunch hour for the freshman and sophomore girls was a valued time for them to meet older boys, who were potential dating partners. Dating patterns at the school which made it unlikely that younger boys would date older girls made this a less valuable opportunity for their male peers.

Once this pattern of predominantly male attendance at the lab was established it was maintained, even strengthened, by the fact that students often persuaded their friends who had not come to the lab before to try it. Thus, boys were likely to be brought to the lab by friends and, in effect, their entry into the social network there was sponsored by others. Given that few girls initially attended the lab and that there was a marked tendency for students to have friends of their own gender,

the probability that girls would be persuaded to give the lab a try by others who sponsored them during their first few forays into this new setting was very low. (A similar phenomenon seemed to help account for the fact that black students were underrepresented in the lab relative to their enrollment in the gifted program).

The next chapter looks at another parallel gender-linked phenomenon -- the striking underrepresentation of female students in advanced computer science classes relative both to their proportion in the school and to their enrollment in the introductory level computer science classes. It suggests that numerous factors, ranging from administrative decisions about the departmental location and the name of the course to gender stereotyped course materials and assignments, discouraged female students from pursuing computer science. In addition, it presents detailed case studies of the four female students who did enroll in Computer Science 2 during the two years of this study. Although these four students were quite different individuals and there were marked differences in their male classmates' reactions to them, certain patterns were quite evident. For example, there was a strong tendency for these students to be isolated socially and academically. Not one of them entered into the kind of continuing working partnership with peers that the majority of the male students did. This fact had academic as well as social consequences since male students received a great deal of help from their peers and also often benefitted from giving help as well. Two of the four girls in the advanced computer science classes appeared at some level to accept their isolation, one immersing herself in her work and the other becoming thoroughly alienated from the class and students in it. The latter student frequently cut class and tended to be angry and hostile when she came, which was hardly surprising given that she was

often harassed her by her male classmates who on the one hand teased her about her physical appearance and on the other made mock sexual approaches to her. The other two girls made clear attempts to break out of this isolation. One of them tried with only partial success to become "just one of the boys," combining a boisterously proclaimed interest in sports with generous complements to others on their programs and frequent gifts of candy and other snacks. The other, clearly the most successful in all four in integrating herself into the academic and social life of the classroom, was a cheerleader who quashed any doubts her femininity entertained by her classmates with remarks like "Let's go fail chemistry," although, according to teachers who purported to know, she was quite competent in such subjects.

The book's closing chapter reviews and integrates the findings presented in the preceding chapters, which are in essence a series of interconnected case studies. It concludes that virtually all of the varied instructional uses of computing studied had significant unanticipated effects on the social functioning of the classrooms in which they were embedded. Some of these effects, such as certain changes in the relationship between teachers and their students, seemed quite similar across very different kinds of applications. Others seemed to be importantly influenced by very specific features of the software or of classroom situations in which the computers were used. Finally, this chapter reiterates the crucial importance of recognizing the degree to which the use of technological devices such as computers is shaped by the social context in which they are found and of taking this phenomenon into consideration in activities ranging from software development to training individuals to use the technology.

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April 7, 1993

Dear Colleague:

Attached is a Publications List which was inadvertently left off of a final ONR report entitled "The Impact of an Intelligent Computer-Based Tutor on Classroom Social Processes: An Ethnographic Study" which I recently sent to you.

Sincerely,



Janet W. Schofield
Professor of Psychology

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enclosures

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Products Stemming From "The Impact of an Intelligent
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Publications

- Schofield, J. W., & Evans-Rhodes, D. (1989). The impact of a computer-based tutor on teachers and students. In D. Bierman, J. Breuker, & J. Sandberg (Eds.), Artificial Intelligence and Education: Proceedings of the 4th International Conference on AI and Education. Springfield, VA: IOS.
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